- 6 Lines per link x 0.2 Erlangs/Line = 1.20 Erlangs

- $\frac{30\ MHz \times 2.4\ bits/Hz}{64\ KB} = 1,125$ (64KB lines) Per Sec

- Grade of Service 0.1 % (Erlang B) allows 93% or better efficency

- Required Traffic channels $\frac{1.20}{.93} = 1.29$

DBA = $(1.2 \times 64) + (64+16) = 163$ kbs

$\frac{163\ kbs}{2.4\ bps/Hz} = 67.7\ KHz$ $\quad 67.7\ KHz \times 1.1 = 74.5$ kH

FBA = $(6 \times 64) + (64+16) = 464$ kbps

$\frac{464\ kbps}{2.4} = 193.3\ KHz$

$\frac{193.3}{74.5} = 2.59$

# DOCUMENT #8

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January 22, 1997

Via Facsimile

Mr. Steve Sharkey
Acting Chief, Satellite Engineering Branch
International Bureau
Federal Communications Commission
2000 M Street, N.W.
Washington, D.C. 20554

Re: Dynamic Bandwidth Allocation

Dear Steve:

As a follow-up to our meeting this morning, enclosed is a description of the methodology used to calculate the comparative spectral efficiency of dynamic bandwidth allocation versus fixed bandwidth allocation. I hope that this will prove helpful.

Should you have any questions or require any additional information, please do not hesitate to call.

Very truly yours,

Jay L. Birnbaum

cc: Richard Parlow
Laurence Harris

## Impact of Change in Dynamic Bandwidth Allocation

Microwave Services, Inc.'s ("MSI") and Digital Services Corporation's ("DSC") 18 GHz DEMS systems employ a dynamic bandwidth allocation ("DBA") scheme, rather than fixed bandwidth allocation ("FBA"), to maximize system capacity without any disruption of service to the customer during customer premises equipment ("CPE") configuration transitions.

Under a DBA approach, the total bandwidth requirement of all customers within a sector is considered collectively. Using traffic engineering principles, capacity is designed for a given grade of service. As the information throughput requirements of a particular customer changes, the system tests and then establishes a second link with the customer (on a different carrier) that meets the changed requirements. Once the second link with the customer is fully tested and established, the system automatically shuts off the original link, leaving the new link in place. In order to test and then establish the new higher-capacity link before the original link is shut off, the DBA implementation requires an additional 4 dB of backoff in the transmitter power amplifier compared to the power backoff that is required for amplifier operation without DBA. This is due to the need for the additional link and the resulting additional intermodulation that would result without additional backoff.

In an FBA scheme, each customer would be assigned a dedicated (fixed) number of n x 64 kb individual circuits. By implementing FBA in place of DBA, MSI and DSC could achieve an improvement of 4 dB in the link budget by eliminating the need for transmitter power backoff. This 4 dB improvement could be used to compensate for some of the increase in rain attenuation and transmitter power loss at 24 GHz. At the same time, however, by employing FBA rather than DBA, MSI and DSC would sacrifice system capacity by a factor of 2.59 or more. Therefore, as shown below, MSI and DSC would need to increase the bandwidth by a minimum of 2.59 times just to maintain the same capacity at 24 GHz that is possible at 18 GHz, other factors such as modulation and power being equal.

Whether MSI's and DSC's DEMS systems use DBA or FBA, each radio link requires a 16 kbps channel for radio frame overhead and a 64 kbps overhead for channel signaling information. For example, assuming 6 voice lines per link and 0.2 Erlangs of traffic per line, the total amount of traffic per link would equal 1.20 Erlangs. Using the calculated Erlang B trunking efficiency of 93% (based on traffic aggregated across the entire sector presented to the nodal station

and a blocking rate comparable or better to that of a landline system), the system would have to allocate 1.20/93% traffic channels, or approximately 1.29 traffic channels on average, to accommodate the customer link. Since each voice channel requires 64 kbps, the total bandwidth allocated for a 6-line link using DBA would be:

(traffic channel bandwidth) + (overhead bandwidth) =
(1.29 x 64) + (64 + 16) = 163 kbps

If system link performance required that FBA be used instead of DBA, each radio link would require more bandwidth. The overhead FBA requires 80 kbps (16 kbps for radio frame overhead and 64 kbps for signaling). Each line requires a dedicated 64 kbps channel, so the total bandwidth required for a 6-line link using FBA would be:

(traffic channel bandwidth) + (overhead bandwidth) =
(6 x 64) + (64 + 16) = 464 kbps

The amount of spectrum required to deliver a given amount of bandwidth (in kbps) is equal to the bandwidth required divided by the spectral efficiency performance (in bits per second-per-Hertz) of the modulation scheme being used. In this case, if we assume that 16-TCM is used, the 6-line link using FBA would require 464 kbps/ 2.4 bps/Hz, or 193.3 kHz. The same link using DBA would require 163 kbps/ 2.4 bps/Hz, or 67.7 kHz. Assuming conservatively that an additional 10% of this spectrum is held in reserve to accommodate the dual carrier requirements of the DBA algorithm, the total amount of spectrum required for this link would be 74.5 kHz (67.7/0.9 = 74.5). Therefore, in this example, the FBA link would require 193.3/74.5, or 2.59 times the amount of spectrum as the DBA link.

In the above example, we have conservatively used 0.2 Erlangs for busy hour traffic per line. However, busy hour traffic for business customers typically is closer to 0.1 Erlang and for residential customers even less. Lower traffic per line will make FBA even more inefficient (*i.e., ratio of greater than 2.59 times*) as compared to DBA.